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APPLICANT: Junichi OGIKUBO, Kanagawa, Japan

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Durnford Geszvain, Dillon

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Hon. Commissioner of Patents and Trademarks,
Washington, D. C. 20231

SIR:

CERTIFIED TRANSLATION

I, Kenichi AIHARA, am an official translator of the Japanese language into the English Language and I hereby certify that the attached comprises an accurate translation into English of Japanese Patent Application No. 2002-332654, filed on November 15, 2002.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Kenichi AIHARA

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INVENTOR:
address: c/o Sony Corporation
7-35, Kitashinagawa 6-chome, Shinagawa-ku,
TOKYO, JAPAN
name: Junichi OGIKUBO

APPLICANT:
identification number: 000002185
name: Sony Corporation

PROXY:
identification number: 100090376
patent attorney
name: Kunio Yamaguchi
telephone: 03-3291-6251

APPOINTED PROXY:
identification number: 100095496
patent attorney
name: Eiji Sasaki
telephone: 03-3291-6251

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**[Name of the Document] Specification**

**[Name of the Invention] Imaging Apparatus, Imaging Method, Signal-recording Apparatus, and Signal-recording Method**

**[Scope of Claim for a Patent]**

**[Claim 1]** An imaging apparatus characterized in that the imaging apparatus comprises:

imaging means for reading a signal out of an image pickup device so as to generate an image signal based on captured image;

signal-processing means for generating image data based on said image signal;

control means for controlling operation of said imaging means and said signal-processing means to change a frame rate of said image data to a desired set frame rate, and generating associated information for indicating said set frame rate; and

transmitting means for combining said associated information with said image data to transmit them.

**[Claim 2]** The imaging apparatus according to Claim 1, characterized in that said control means changes the frame rate of said image data by means of altering timing of reading the signal from said image pickup device.

**[Claim 3]** The imaging apparatus according to Claim 1, characterized in that said control means changes the frame rate of said image data by means of controlling said signal-processing means to perform frame-skipping.

**[Claim 4]** The imaging apparatus according to Claim 1, characterized in that said control means changes the frame rate of said image data by means of altering timing of reading the signal from said image pickup device and

controlling said signal-processing means to perform addition on a frame basis.

**[Claim 5]** The imaging apparatus according to Claim 1, characterized in that said control means adds a sub-frame number to each of the frames of said set frame rate included within one frame period of reference frame rate so as to include said sub-frame number in said associated information.

**[Claim 6]** The imaging apparatus according to Claim 1, characterized in that said signal-processing means samples analog audio signal to generate audio data;

said control means controls a sampling frequency of said analog audio signal in said signal-processing means based on said set frame rate; and

said transmitting means combines said associated information with said image data and said audio data to transmit them.

**[Claim 7]** An imaging method characterized in that the method comprises the steps of:

reading a signal out of an image pickup device to generate an image signal based on captured image;

changing a frame rate of said image data to a desired set frame rate when generating image data based on said image signal, and generating frame rate information for indicating said set frame rate; and

combining associated information containing said frame rate information with said image data to transmit them.

**[Claim 8]** The imaging method according to Claim 7, characterized in that the frame rate of said image data is

changed by means of altering timing of reading the signal from said image pickup device.

**[Claim 9]** The imaging method according to Claim 7, characterized in that the frame rate of said image data is changed by means of performing frame-skipping.

**[Claim 10]** The imaging method according to Claim 7, characterized in that the frame rate of said image data is changed by means of altering timing of reading the signal from said image pickup device and performing addition on a frame basis.

**[Claim 11]** The imaging method according to Claim 7, characterized in that a sub-frame number is added to each of the frames of said set frame rate included within one frame period of reference frame rate so as to include said sub-frame number in said associated information.

**[Claim 12]** The imaging method according to Claim 7, characterized in that analog audio signal is sampled so as to generate audio data, a sampling frequency of said analog audio signal is controlled based on said set frame rate, and said associated information is combined with said image data and said audio data so as to transmit them.

**[Claim 13]** Signal-recording apparatus characterized in that the apparatus comprises:

signal-recording-and processing means for generating a record signal from record data which combines main data indicating audio and/or video with associated information containing frame rate information of the main data;

recording means for recording on record medium the record signal generated in the signal-recording-and-processing means; and

control means for controlling the signal-recording- and processing means and the recording means.

**[Claim 14]** Signal-recording method characterized in that the method comprises the steps of:

generating a record signal from record data which combines main data indicating audio and/or video with associated information containing frame rate information of the main data; and

recording on record medium the record signal.

**[Detailed Description of the Invention]**

**[0001]**

**[Technical Field Pertinent to the Invention]**

The invention relates to an imaging method, an imaging apparatus, signal-recording apparatus, and signal-recording method. Particularly, it relates to an imaging method and the like of reading a signal out of an image pickup device to generate an image signal based on captured image, changing a frame rate of said image data to a desired set frame rate when generating image data based on said image signal, and generating frame rate information for indicating said set frame rate, and combining associated information containing said frame rate information with said image data to transmit them, or recording the image data with which the associated information is combined on record medium.

**[0002]**

**[Prior Art]**

In generation of contents on audio and/or video for broadcasting, it has been often done to generate the contents altering motion speed partially, in order to obtain enhanced effects the creator wishes to create.

**[0003]**

In such the generation of contents altering the motion speed, for example, a higher frame rate relevant to a reference frame rate is illustratively set to generate the contents, and then the contents are reproduced at the reference frame rate so that slow motion contents can be produced. Alternatively, a lower frame rate relevant to a reference frame rate is set to generate the contents, and then the contents are reproduced at the reference frame rate so that quick motion contents can be produced. Further, by adapting the frame rate to be set and the frame rate at the reproduction, it is possible to alter the motion speed freely.

**[0004]**

Thus, the creator creates the contents for broadcasting using not only the contents generated at the reference frame rate but also the contents of altered motion speed, in order to obtain the enhanced effects the creator wishes to create when the contents are reproduced at the reference frame rate.

**[0005]**

The video camera allowing time axis to be compressed or extended in order to allow the contents obtained by thus altering the frame rate to be generated has been proposed in, for example, patent document 1.

**[0006]**

**[Patent Document]**

Japanese Patent Publication No. H11-177903

**[0007]**

**[Problems to be solved by the Invention]**

When, however, the contents to be used for broadcasting are generated using not only the contents generated at the reference frame rate but also the contents of altered motion speed as material, as described above, it is not easily determined at editing which of frame rates each of the contents has been generated if merely the material image is displayed. Further, when it performs the speed change on the contents of altered motion speed, it is impossible to determine whether or not the speed change can be performed without any deterioration in image quality. For example, if a frame rate is set (hereinafter, referred to as, "set frame rate") to 10 times the reference frame rate, the reproduced contents are displayed one-tenth in a motion if the contents generated at the set frame rate are reproduced at the reference frame rate. Here, it is conceivable that since the set frame rate is 10 times the reference frame rate when wanting to display the contents one-fifth in a motion, the speed change can be easily performed without any deterioration in image quality if performing a frame-skipping for each frame. It, however, is impossible to determine whether or not the speed change can be performed without any deterioration in image quality, easily based on merely the displayed image.

**[0008]**

Accordingly, the present invention presents an imaging method, an imaging apparatus, a signal-recording apparatus, and a signal-recording method wherein determining which of frame rates the imaging has been performed is easily allowed.

**[0009]**

**[Means for Solving Problem]**

An imaging apparatus according to the present invention comprises imaging means for reading a signal out of an image pickup device so as to generate an image signal based on captured image, signal-processing means for generating image data based on said image signal, control means for controlling operation of said imaging means and said signal-processing means to change a frame rate of said image data to a desired set frame rate, and generating associated information for indicating said set frame rate, and transmitting means for combining said associated information with said image data to transmit them.

**[0010]**

Further, an imaging method according to the present invention comprises the steps of reading a signal out of an image pickup device to generate an image signal based on captured image, changing a frame rate of said image data to a desired set frame rate when generating image data based on said image signal, and generating frame rate information for indicating said set frame rate, and combining associated information containing said frame rate information with said image data to transmit them.

**[0011]**

Further, a signal-recording apparatus comprises signal-recording-and processing means for generating a record signal from record data which combines main data indicating audio and/or video with associated information containing frame rate information of the main data,

recording means for recording on record medium the record signal generated in the signal-recording-and-processing means, and control means for controlling the signal-recording-and processing means and the recording means.

**[0012]**

Additionally, signal-recording method comprises the steps of generating a record signal from record data which combines main data indicating audio and/or video with associated information containing frame rate information of the main data, and recording on record medium the record signal.

**[0013]**

In the present invention, when reading signal out of an image pickup device so as to generate image signal based on captured image, and generating image data based on the image signal, the frame rate of the image data is changed by means of altering timing of reading the signal from the image pickup device, the frame rate of said image data is changed by means of performing frame-skipping, or the frame rate of said image data is changed by means of altering timing of reading the signal from said image pickup device and performing addition on a frame basis. By changing the frame rate of the image data to a desired set frame rate and generating the frame rate information indicating the set frame rate, the image data indicating this image is made main data, and the associate information containing the frame rate information is combined with the main data so as to be transmitted. Alternatively, the associated information includes the sub-frame number in addition to the frame of the set frame

rate included within one frame period of reference frame rate. Further, analog audio signal is sampled so as to generate audio data and a sampling frequency thereof is controlled based on the set frame rate. The image data and the audio data indicating audio and video becomes the main data, and the associated information is combined with the main data so as to transmit them. Alternatively, the data obtained by combining the main data with the associated information becomes the record data, and a record signal is generated based on the record data and recorded on the record medium such as videotape and disc-like record medium.

**[0014]**

**[Mode for Carrying Out the Invention]**

An embodiment of this invention will now be described. Fig. 1 shows an entire configuration of contents-providing system for providing the contents, for example, for audio and/or video. An imaging apparatus 10 generates image data having its changed frame rate and combines associated information including frame rate information indicating the frame rate of the image data with this image data to supply a signal recording apparatus 20 or an editing apparatus 30 with the combined ones as material data DTm. When the imaging apparatus 10 is provided with an audio input apparatus 19, it generates audio data to supply the signal recording apparatus 20 or the editing apparatus 30 with the audio data and the associated information as material data DTm.

**[0015]**

The signal recording apparatus 20 records the

supplied material data DTm on recording medium. It also reproduces the material data DTm recorded on the recording medium and supplies it to the editing apparatus 30. The imaging apparatus 10 and the signal recording apparatus 20 may be combined together each other as so-called "dockable" typed camera/recorder system, and the imaging apparatus 10 and the signal recording apparatus 20 may be separately provided with them being connected through a cable.

**[0016]**

The editing apparatus 30 performs editing process using the material data DTm supplied from the imaging apparatus 10 or the signal recording apparatus 20 and produces image data and audio data the editor wishes to create. It also combines associated information including frame rate information with the image data and the audio data thus produced to generate contents-data DC for broadcasting, distribution, and the like.

**[0017]**

Fig. 2 shows a configuration of the imaging apparatus 10. Light incident through imaging lens system 11 is made incident to an imaging unit 12 and a subject image is formed on an image surface of an image pickup device such as charge coupled device (CCD) mounted within the imaging unit 12. The image pickup device generates imaged charge of the subject image though photoelectric transfer characteristics thereof. It also reads out the imaged charge thus generated on the basis of driving signal CR from a timing generator 142, which will be described later, and generates imaged signal Sp having a frame rate that

corresponds to the driving signal CR to supply it to camera processing circuit 131 in signal processing unit 13.

**[0018]**

Based on timing signal CT supplied from the timing generator 142, the camera processing circuit 131 performs various signal processing at timings synchronized with the imaged signal Sp. Illustratively, noise-reduction processing for reducing noise components from the imaged signal Sp by means of correlated dual sampling or the like, transformation processing from the imaged signal Sp thus noise-reduced to digital image data, clamp processing of the image data, processing on shading correction and pilling-up of deficiency in the image pickup device, $\gamma$ correction, contour enhancement processing, knee correction, and the like are performed. Further, various signal processing are performed under the process conditions based on the operation control signal CS supplied from imaging control circuit 141 of control unit 14. Thus, the image data DV generated according to various signal processing in the camera processing circuit 131 is supplied to the transmitting unit 15.

**[0019]**

The timing generator 142 of the control unit 14 generates driving signal CR corresponding to operation control signal CS from the imaging control circuit 141 and supplies it to the imaging unit 12, thereby allowing a reading-out timing of imaged charge in the imaging unit 12 to be altered. It, then, also controls a frame rate of the imaged signal Sp to be equal to a set frame rate FRs based on an operation signal PSa from user interface unit

16. For example, if frame frequency, 59.94Hz or 29.97Hz in the case of NTSC system or frame frequency, 50Hz or 25Hz in the case of PAL system is set to the frame frequency of reference frame rate FRr and an operation such that the set frame rate FRs is set to the one n times the reference frame rate FRr is carried out (k is positive value, not limited to an integer), a frame rate of the imaged signal Sp is controlled to be equal to the one n times the reference frame rate FRr.

**[0020]**

The timing generator 142 also generates timing signal CT synchronized with the driving signal CR and supplies it to the camera processing circuit 131 and audio processing circuit 132. The timing generator 142 further generates frame rate information DM-FRs indicating the set frame rate FRs that is frame rate of image data DV and supplies it to the transmitting unit 15. The timing generator 142 also generates sub-frame number BN. This sub-frame number BN is identification number for identifying each frame included in each of the frame periods of the reference frame rate FRr when the set frame rate FRs is set to be higher than the reference frame rate FRr. This sub-frame number BN is supplied to the transmitting unit 15 as frame identification information DM-BN.

**[0021]**

Fig. 3 is a flowchart showing an offer operation of sub-frame number in the timing generator 142. The timing generator 142 performs a frequency division on oscillated signal of a predetermined frequency, for example, to set the set frame rate FRs so that the frame periods of the

reference frame rate FRr and the set frame rate FRs may be synchronized with each other, and generates a frame reference timing indicating a generation of the driving signal CR and a breakpoint between the periods of frames of reference frame rate FRr based on the frame period of the set frame rate FRs.

**[0022]**

At step ST1, it is determined whether or not the frame reference timing is detected. If the frame reference timing is detected, the process goes to step ST2. If no frame reference timing is detected, the process goes back to the step ST1.

**[0023]**

When the frame reference timing is detected at the step ST1, the process goes to the step ST2, as described above, where the sub-frame number BN is initialized, thus setting the sub-frame number BN to an initial value, for example, 0 and the process then goes to step ST3.

**[0024]**

At the step ST3, it is determined whether or not the frame reference timing has been detected during a period of time starting from detecting the frame reference timing and ending before one frame of period of the set frame rate FRs has been passed. If no frame reference timing is detected, the process goes to step ST4 where 1 is added to the sub-frame number BN and then the added sub-frame number BN is updated and the process then goes back to step ST3. Thus, when no frame reference timing has been detected before one frame of period of the set frame rate FRs has been passed, the sub-frame number BN is allocated

in sequence to the set frame rate FRs for each of the frames of periods thereof.

**[0025]**

Thereafter, when the frame reference timing is detected before one frame of period of the set frame rate FRs has been passed, the process goes back to the step ST2 where the sub-frame number BN is initialized.

**[0026]**

Every frame of period of the reference frame rate FRr, the sub-frame number BN may be added to the frame image of the set frame rate FRs provided during a frame period of time.

**[0027]**

The imaging control circuit 141 of the control unit 14 shown in Fig. 2 is connected with the user interface unit 16. When, in the imaging apparatus 10, switching operation and alteration operation of the frame rate are performed, the user interface unit 16 generates operation signal PSa corresponding to these operations and supplies it to the imaging control circuit 141. When supplying the operation signal PSa from external equipment, the user interface unit 16 supplies the imaging control circuit 141 with the operation signal PSa.

**[0028]**

The imaging control circuit 141 generates operation control signal CS to allow the imaging apparatus 10 to be operated according to the operation signal PSa based on the operation signal PSa from the user interface unit 16 and also supplies it to the camera processing circuit 131 and the timing generator 142.

**[0029]**

To the audio processing circuit 132, analog audio signal Sin is supplied from audio input apparatus 19. The audio processing circuit 132 also performs sampling process on the audio signal Sa based on timing signal CT supplied from the timing generator 142 to generate digital audio data DA and supply it to the transmitting unit 15.

**[0030]**

The transmitting unit 15 generates associated information DM including the frame rate information DM-FRs and the frame identification information DM-BN and combines it with the image data DV and the audio data DA to generate material data DTm and supplies it to the signal recording apparatus 20 or the editing apparatus 30. The associated data DM may include not only information on the set frame rate FRs and the sub-frame number BN but also information on imaged date and time, imaged condition, imaged contents, and the like.

**[0031]**

Herein, if combining the image data DV and the audio data DA with the associated information, the associated information DM is inserted into a data stream of image or a header of the data stream when the image data DV and the audio data DA are compressed to generate the material data DTm as the data stream. For example, when a moving picture compression system in Moving Picture Experts Group (MPEG) standardized as ISO (International Organization for Standardization)/IEC (International Electrotechnical Commission) 13818-2 is utilized, the associated information DM may be inserted into a region for extension

or the like provided in a picture layer, thereby allowing the associated information DM to be inserted on a picture basis. Alternatively, when a synchronization multiplexed system in MPEG standardized as ISO/IEC 13818-2 is utilized, the associated information DM may be inserted into an optional field or the like provided in a header in Packetized Elementary Stream (PES).

**[0032]**

Further, when SDI format standardized as SMPTE (Society of Motion Picture and Television Engineers) 259M, Television-10-Bit 4:2:2 Component and 4fsc Composite Digital Signals-Serial Digital Interface, in order to transfer non-compressed image and audio data, SDTI format standardized as SMPTE 305M, Television-Serial Data Transport Interface (SDTI), in order to transfer compressed image and audio data, or SDTI-CP format standardized as SMPTE 326M, Television-SDTI Content Package Format (SDTI-CP) that obtained by further defining SDTI format is utilized, it may be inserted into a signal having each format as UMID data standardized as SMPTE 330M, Television-Unique Material Identifier (UMID).

**[0033]**

UMID is an identifier for uniquely identifying material data such as image data and audio data. UMID defines Basic UMID or Extended UMID that is identifier as being obtained by adding Signature Metadata to Basic UMID. Basic UMID includes a label for identifying digital data, information for indicating whether or not overwrite or editing is performed on the material data, a number for distinguishing the material data from each other, and the

like. It is configured that signature Metadata includes information on material-data-forming date and time, correction information (information on difference in time) concerning material-data-forming time, location information indicative of latitudes, longitudinal, and altitude, information on name of organization, and the like. Signature Metadata also includes a region for user code, to which the associated information DM may be stored, for example.

**[0034]**

The Extended UMID thus obtained is inserted into each of the signals having various formats. When SDI format is utilized, the Extended UMID is inserted into an ancillary data region, as shown in Fig. 4. When SDTI format is utilized, the Extended UMID is inserted into an ancillary data region except for a header data portion, as shown in Fig. 5. When SDTI-CP format is utilized, the data to be inserted is inserted into a payload region on an item basis. Specifically, as shown in Fig. 6, system item composed of information on image and audio, picture item composed of image data, audio item composed of audio data, and auxiliary (AUX) item composed of other data are inserted in sequence. In the system item, regions for metadata sets such as Package Metadata set, Picture Metadata set, audio Metadata set, and Auxiliary Metadata set are provided to allow the metadata to be inserted thereinto. This permits the extended UMID to be inserted into these regions.

**[0035]**

By the way, the above imaging apparatus 10 alters

read-out timing of imaged charge in the imaging unit 12 to generate the material data DTm of a predetermined set frame rate FRs, thereby allowing the set frame rate FRs to be successively altered. If, however, the set frame rate FRs may be altered solely in a stepwise, frame-skipping allows the material data DTm of a predetermined set frame rate FRs to be generated. This is, generating image data DVa having a constant frame rate higher than the set frame rate FRs and extracting image data of only the set frame rate FRs from the image data DVa allows the material data DTm of a predetermined set frame rate FRs to be generated. Fig. 7 shows a configuration performing such a generation. In Fig. 7, like reference numbers refer to like elements shown in Fig. 2 and thus, the detailed description thereof is omitted.

**[0036]**

Timing generator 182 in control unit 18 generates driving signal CRa corresponding to the highest value of the set frame rate FRs that is set through user interface unit 16 and supplies it to the imaging unit 12. Based on the driving signal CRa, the imaging unit 12 generates imaged signal, i.e., imaged signal Spa having a fixed frame rate FRq higher than a reference frame rate and then supplies it to camera processing circuit 131. When the set frame rate FRs may be altered up to n times the reference frame rate FRr, it generates the imaged signal Spa having a frame rate n times the reference frame rate FRr, and supplies it to the camera processing circuit 131.

**[0037]**

The timing generator 182 also generates timing signal

CTa synchronized with the driving signal CRa and supplies it to the camera processing circuit 131 and audio processing circuit 132 in signal processing unit 17 and effective frame signal generation circuit 183.

**[0038]**

The camera processing circuit 131 supplies image data DVa of fixed frame rate FRq generated based on the imaged signal Spa to the effective data selection circuit 171. The audio processing circuit 132 supplies audio data DAa generated by carrying out a sampling based on the timing signal CTa of a fixed frequency to the effective data selection circuit 171.

**[0039]**

Imaging control circuit 181 generates a set information signal CF indicating a set frame rate FRs based on operational signal PSa received from the user interface unit 16 and supplies it to the effective frame signal generation circuit 183.

**[0040]**

The effective frame signal generation circuit 183 extracts data on a frame basis from the image data DVa based on a ratio of the fixed value of frame rate FRq of the image data DVa to the set frame rate FRs indicated in the set information signal CF and generates extraction control signal CC for generating image data DV of the set frame rate FRs. The effective frame signal generation circuit 183 also synchronizes the extraction signal CC with the timing signal CTa and supplies it to the effective data selection circuit 171. When the frame rate FRq of the image data DVa is n times the reference frame

rate FRr and the set frame rate FRs is n/2 times the reference frame rate FRr, the extraction control signal CC for controlling data extraction on a frame basis is generated every other frame from the image data DVa and is supplied to the effective data selection circuit 171 synchronized with the timing signal CTa.

**[0041]**

The effective frame signal generation circuit 183 further generates frame rate information DM-FRs indicating the set frame rate FRs based on the set information signal CF and supplies it to the transmitting unit 15. Since a number of frames during a period of frame with the reference frame rate FRr may be determined according to the extraction control signal CC, sub-frame number BN is set on a frame during a period of each frame with the reference frame rate FRr and this sub-frame number BN is also supplied to the transmitting unit 15 as the frame identification information DM-BN.

**[0042]**

The effective data selection circuit 171 extracts the image data DVa and the audio data DAa of the frame indicated by the extraction control signal CC and supplies them to the transmitting unit 15 as the image data DV and the audio data DA. It is conceivable that the effective frame signal generation circuit 183 may supply the effective data selection circuit 171 with the frame rate information DM-FRs indicating the set frame rate FRs to perform frame-skipping on the audio data DAa according to a ratio of the set frame rate FRs to a frame rate when the audio data DAa is generated. When the frame rate FRq in

generating the audio data DAa is n times the reference frame rate FRr and the set frame rate FRs is n/2 times the reference frame rate FRr, the frame-skipping is performed on the audio data DAa every other frame. In this case, since an interval of the frame-skipping may be shortened as compared by a case where performing the frame-skipping on the audio data DAa on a frame basis, audio having an excellent sound quality may be get based on the audio data DA.

**[0043]**

Thus, the image data DVa having a fixed frame frequency makes unnecessary the alteration of operation frequencies in the imaging unit 12 and the camera processing circuit 131 of the signal processing unit 17, thereby allowing configurations of the imaging unit 12 and the camera processing circuit 131 to be made simpler. Since only the data extraction on a frame basis from the image data DVa may generate image data DV of the set frame rate FRs, generating the image data DV of a predetermined set frame rate FRs from the image data Dva is easily allowed.

**[0044]**

When the imaging apparatus is provided with video memory or an adder and a divider, it may generate the image data DV by adding the image data every the predetermined frames. In this case, a variable range of frame rate in the imaged signal Sp may be limited and the frame rate FRs may be successively altered. Adding the imaged signal Sp of n frames and dividing the signal level by n allows the signal having a frame rate 1/n times the

imaged signal Sp to be obtained even if a frame rate of the imaged signal Sp is not divided by n. Further, successively altering the read-out frequency of imaged charge allows the set frame rate FRs to be successively altered.

**[0045]**

Figs. 8 and 9 are diagrams showing relationship between the image data DV generated by the imaging apparatus 10, 10a and the associated information DM. When the set frame rate FRs is set to the one equal to or twice the reference frame rate FRr as shown in Fig. 8A, the associated information DM that includes the frame rate information DM-FRs indicating the set frame rate FRs, as shown in Fig. 8C, and the frame identification information DM-BN indicating the sub-frame number BN, as shown in Fig. 8D is combined with image data DV as shown in Fig. 8B (in Fig. 8B, frame images based on the image data DV are shown). It is to be noted that Fig. 8E illustrates a relationship between time and the frame images. The frame rate information DM-FRs may also include a magnification of the set frame rate FRs to the reference frame rate FRr in addition to the set frame rate FRs. The frame rate information DM-FRs is indicated by the magnification in Figs. 8C and follows.

**[0046]**

When the set frame rate FRs is set to the one equal to or half as much as the reference frame rate FRr as shown in Fig. 9A, the associated information DM that includes the frame rate information DM-FRs indicating the set frame rate FRs, as shown in Fig. 9C, and the frame

identification information DM-BN indicating the sub-frame number BN, as shown in Fig. 9D is combined with image data DV as shown in Fig. 9B (in Fig. 9B, frame images based on the image data DV are shown). Fig. 9E illustrates a relationship between time and the frame images.

**[0047]**

Fig. 10 shows a configuration of signal-recording apparatus 20 such as a videotape recorder.

**[0048]**

When the material data DTm that combines main data indicating image and/or audio with the associated information including frame rate information of the main data is input, the material data DTm is supplied to encoder 211 of signal-recording processor 21 as recording data. The encoder 211 produces error-correcting codes and performs data-shuffling, multiplexing, channel coding, and the like based on operation control signal CTM supplied from a recording/reproducing control unit 24, which will be described later, using the material data DTm thus supplied, to generate record signal SW. The generated record signal SW is supplied to a terminal "a" of a changeover switch 212.

**[0049]**

To the changeover switch 212, a switch control signal CTW is supplied from the recording/reproducing control unit 24 and operations of the changeover switch 212 are controlled based on the switch control signal CTW so that the record signal SW can be supplied to recording amplifier 213a or 213b connected to terminal "b" or "c".

**[0050]**

The recording amplifier 213a amplifies the supplied record signal SW and supplies it to signal-switching device 221a of signal recording/reproducing unit 22 constituting the signal recording means and the recording amplifier 213b amplifies the supplied record signal SW and supplies it to signal-switching device 221b.

**[0051]**

When recording a signal, the signal-switching device 221a supplies magnetic head 222a with the signal SW supplied from the recording amplifier 213a based on a changeover control signal CWR from the recording/reproducing control unit 24. When reproducing a signal, the signal obtained by the magnetic head 222a is supplied to reproducing amplifier 231a of the signal reproduction processor 23. Similarly, when recording a signal, the signal-switching device 221b supplies magnetic head 222b with the signal supplied from the recording amplifiers 213b based on a changeover control signal CWR from the recording/reproducing control unit 24. When reproducing a signal, the signal obtained by the magnetic head 222b is supplied to reproducing amplifier 231b of the signal reproduction processor 23.

**[0052]**

Thus, supplying the magnetic heads 222a, 222b built in a rotating drum (not shown) with the amplified record signal SW allows image, audio, and the associated information to be recorded on magnetic tape, which is not shown. The signal recorded on the magnetic tape is read out by the magnetic heads 222a, 222b and is then supplied to the reproducing amplifiers 231a, 231b, respectively.

**[0053]**

The reproducing amplifier 231a amplifies a signal obtained by the magnetic head 222a and supplies it to a terminal "a" of a changeover switch 232. The reproducing amplifier 231b amplifies a signal obtained by the magnetic head 222b and supplies it to a terminal "b" of the changeover switch 232. A terminal "c" of the changeover switch 232 is connected with a decoder 233.

**[0054]**

To the changeover switch 232, a switch control signal CTR is supplied from the recording/reproducing control unit 24 and operations of the changeover switch 232 are controlled based on the switch control signal CTR on which the signals output from the recording amplifiers 213a, 213b, respectively, are selected, so that it can be supplied to the decoder 233 as reproduced signal SR. The decoder 233 decodes the reproduced signal SR and performs data separation, de-shuffling, an error-correcting processing, and the like based on operation control signal CTM supplied from the recording/reproducing control unit 24, thereby generating the material data DTm that combines main data indicating image and/or audio with the associated information including frame rate information of the main data and then transmitting them.

**[0055]**

The recording/reproducing control unit 24 is connected with interface unit 25 and generates the switch control signals CTW, CTR and the operation control signals CTM, CTM controlling operations of the encoder 211 and the decoder 233, respectively, based on the operational signal

PSv supplied from the user interface unit 25 or another operational signal PSw from an external apparatus such as the editing apparatus 30. The recording/reproducing control unit 24 also performs a driving control of a magnetic tape or a rotation head. The recording/reproducing control unit 24 further generates a display signal PH and supplies display unit 26 with it to display an operational condition of a video tape recorder, and various kinds of information and the like.

**[0056]**

Although a case where the material data DTm is recorded on the magnetic tape has been shown in Fig. 10, it may be recorded on disk-like optical or magnetic recording medium or signal-reproduction device using semiconductor storage element.

**[0057]**

The signal-recording apparatus 20 is enough if the image data DV and audio data DA are combined with the associated information DM and they are recorded or transmitted. Thus, the material data DTm to be input is not limited to the one having the associated information inserted into the data stream, header, or the like, so that, for example, it may be supplied through different signal lines.

**[0058]**

Combining the main data with the associated information DM allows editing processing and variable speed reproduction to be easily performed using the data generated by the imaging apparatus 10, 10a or the data recorded on the recording medium by the signal-recording

apparatus 20.

**[0059]**

During an editing process of the data combining the main data with the associated information DM, a speed available for a reproduction may be set based on the set frame rate FRs. This speed is set so that a natural reproduction image can be realized through a frame-skipping of a predetermined frame period or a frame repetition. For example, if a multiple of the set frame rate FRs to the reference frame rate FRr is more than one, the speed available for reproduction can be set by searching for the divisors of this multiple other than one and calculating the reciprocals of the searched divisors. Namely, if the set frame rate FRs is 10 times the reference frame rate FRr, the divisors are of 2, 4, 5, and 10 and thus, the reciprocals thereof are of 1/10, 1/5, 1/4, and 1/2, respectively. Selection of one of the reciprocals of divisors allows the speed available for reproduction to be set to less than the same speed as normal reproduction speed. When the speed available for reproduction not less than the same speed as the normal reproduction speed is set to positive integer multiples of the normal reproduction speed, the frame-skipping periods in each of the speeds available for reproduction may be equal to each other.

**[0060]**

If a multiple of the set frame rate FRs to the reference frame rate FRr is less than one, the speed available for reproduction is set by searching for the reciprocals of this multiple and calculating the divisors

of the searched reciprocals or integer multiples of the reciprocals. Namely, if the set frame rate FRs is 1/6 times the reference frame rate FRr, the divisors of the reciprocals are of 2, 3, and 6 and the integer multiples of the reciprocals are of 6, 12, 18, ---, respectively. Selection of one of them to set the speed available for reproduction allows frame-skipping periods or numbers of the frame repetitions in each of the speeds available for reproduction to be equal to each other. The speed available for reproduction of less than the same speed as the normal reproduction speed is set to the one/positive multiples the normal reproduction speed, thereby allowing numbers of the frame repetitions in each of the speeds available for reproduction to be equal to each other. Since, however, this is concerned with a repetition of images, a lower limit of the speed available for reproduction may be set to the same speed as the normal reproduction speed.

**[0061]**

Figs. 11 illustrate GUI representations each for an editing operation using the associated information. For example, in each of the GUI representations, a material administration browser 401 as material administration display is provided at an upper-left side thereof and a story board 402 as reproduction order display is provided at an lower-left side thereof. A monitor viewer 403 as reproduced image display for displaying an image before or after the editing process is provided at a middle of the screen and a time line 404 as reproduction time order display is provided at a lower-middle thereof. An

operation control bar 405 is provided between the monitor viewer 403 and the time line 404.

**[0062]**

The material administration browser 401 shows a list of items of the material data available for editing and for each item of the material data, a stamp view (a thumbnail view) for indicating a title, a length, contents of items of the stored material data is shown.

**[0063]**

The story board 402 serves as a working area for a production of contents and arranging the items of material data on the reproduced order allows the contents to be produced. The monitor viewer 403 represents not only an image based on the material data but also a location of reproduction and a variable speed bar for indicating a variable range of reproduction speed.

**[0064]**

The time line 404 serves as a working area for a production of contents according to a more detailed method to allocate items of the material data along a time axis. The operation control bar 405 represents an operation key for reproducing the items of material data and the contents arranged on the time line 404.

**[0065]**

When reproducing the selected material data, the set frame rate FRs is determined on the basis of the associated information DM, and then, such a calculation that the reproduction speed FP multiplied by the set frame rate FRs equals a determined value FD is performed and reproduction process conditions are determined on the

determined value FD. For example, when the reproduction speed is the same speed as the normal reproduction speed as shown in Fig. 11A and the set frame rate FRs is 10 times the reference frame rate FRr, the reproduction speed FP multiplied by the set frame rate FRs equals the determined value FD as (1×10=10).It is to be noted that Fig. 12A illustrates images based on the image data DV where the set frame rate FRs is 10 times the reference frame rate FRr. Fig. 12B illustrates the frame rate information DM-FRs for indicating the set frame rate FRs of each of the frame images; Fig. 12C illustrates the frame identification information DM-BN for indicating the sub-frame numbers BN; and Fig. 12D illustrates the absolute frame numbers AN of the frame images. Since the set frame rate FRs is 10 times the reference frame rate FRr, there are 10 frame images of the set frame rate FRs within one frame period of the reference frame rate FRr, thereby repeating the sub-frame numbers of zero through nine.

**[0066]**

When the determined value FD is set to 10, namely, FD=10, as shown in Figs. 12E through 12G, the image signal Svm is generated using every 10 frames, namely, with the image data of nine frames being skipped, thereby allowing reproduced image having same speed as the normal reproduction speed to be represented on the monitor viewer 403 based on the image signal Svm. It is to be noted that Fig. 12E illustrates the absolute frame numbers AN of the images to be displayed; Fig. 12F illustrates the sub-frame numbers BN of the images to be displayed; and Fig. 12G

illustrates frame images represented by the image signal Svm.

**[0067]**

Next, if an operation is carried out such that an indicated width of a frame image representation region 404a in the time line 404 is enlarged along a direction indicated by an arrow A or a position of a sliding cursor 404d represented by a short bold line in a console indication 403c for variable speeds in the monitor viewer 403 is slid on a direction indicated by an arrow B, it is treated so that a processing as the slow motion of reproduction is performed. For example, herein, when it is set to 1/10 times, a reproduction speed indication 403b in the monitor viewer 403 is altered to "× 0.1" as shown in Fig. 11B. At the same time, a cursor position in the console indication 403c for variable speeds is set to a tenth times the normal reproduction speed. Since the long reproduction time is required, the indicated width of the frame image representation region 404a is also enlarged.

**[0068]**

If the speed available for reproduction is set to 1/10 times the normal reproduction speed as shown in Fig. 11B, the determined value FD is set to one, namely, $FD=10\times(1/10)=1$. When the determined value FD is set to one, namely, FD=1, the image signal Svm is generated using every FD=1 frame of the image data DV, thereby allowing the reproduced images having a tenth times the normal reproduction speed to be represented on the monitor viewer 403 based on the image signal Svm, as shown in Fig. 12A.

**[0069]**

if an operation is carried out such that an indicated width of the frame image representation region 404a in the time line 404 is shortened along a direction indicated by an arrow B or a cursor position of the console indication 403c for variable speeds is slid on a direction indicated by an arrow A, it is treated that processing as the quick motion of reproduction is performed. For example, when it is set to twice as much as the normal reproduction speed, a reproduction speed indication 403b in the monitor viewer 403 is altered to "× 2.0" as shown in Fig. 11C. At the same time, a cursor position of the console indication 403c for variable speeds is set to twice of the normal reproduction speed. Since the short reproduction time is required, the indicated width of the frame image representation region 404a is shortened, as shown in Fig. 11C.

**[0070]**

If the speed available for reproduction is set to twice of the normal reproduction speed as shown in Fig. 11C, the determined value FD is set to 20, namely, FD=10×2=20. When the determined value FD is set to 20, namely, FD=20, the image signal Svm is generated using every 20 frames, namely, with the image data of nineteen frames being skipped, thereby allowing the reproduced images having twice speed as much as the normal reproduction speed to be represented on the monitor viewer 403 based on the image signal Svm, as shown in Figs. 12H through 12K. It is to be noted that Fig. 12H illustrates the absolute frame numbers AN of the images to be displayed; Fig. 12J illustrates sub-frame numbers BN of

the images to be displayed; and Fig. 12K illustrates the frame images represented by the image signal Svm.

**[0071]**

Thus, by combining the material data of the set frame rate FRs as various kinds of the reproduction speeds with each other using the associated information DM, it is possible to generate predetermined contents-data for broadcasting, a distribution, and the like easily. Further, when the edited image data is combined with the corresponding associated information to generate the contents-data, the user side performs the same processing as the one performed in the editing apparatus using the associated information included in the contents-data, thereby allowing the reproduction speed of contents to be altered at the user side. For example, if the set frame rate FRs is set to the one higher than the reference frame rate FRr to generate the material data such as sports event casting and then, using the material data, the contents-data including the associated information is generated, the user can see only a predetermined scene in a slow motion with other scenes being seen in normal reproduction speed.

**[0072]**

**[Effects of the Invention]**

According to the invention, a signal is read out of an image pickup device; an image signal based on captured image is generated; when generating image data based on the image signal, a frame rate of the image data alter to a predetermined set frame rate and frame rate information for indicating the set frame rate is generated; and the

associated information including the frame rate information is combined with the image data to transmit them. By, thus, using this frame rate information, it is possible to perform the variable speed reproduction.

**[0073]**

Since the frame rate of the image data alters by altering the timing of reading a signal out of an image pickup device, the frame rate of the image data can be freely changed. Since the frame rate of the image data alters by performing frame-skipping, the configuration of the imaging apparatus can be made simple. Further, since the frame rate of the image data alters by altering the timing of reading the signal out of the image pickup device and performing addition on a frame basis, the frame rate of the image data can be freely changed and a range of altering the timing of reading the signal out of the image pickup device can be limited.

**[0074]**

Since a sub-frame number is added to each of the frames of the set frame rates included within a frame period of reference frame rate so as to include the sub-frame number in the associated information, it is possible to perform the frame-skipping on the image data easily when performing the frame-skipping on the image data on a frame basis.

**[0075]**

Further analog audio signal is sampled to generate audio data, a sampling frequency of the analog audio signal is controlled based on the set frame rate, and the associated information is combined with the image data and the audio data to transmit them. Thus, it is possible to

perform the variable speed reproduction on the audio in addition to the image comforting the image.

**[0076]**

Since a record signal is generated from the record data which combines the main data indicating audio and/or video with the associated information containing frame rate information of the main data and the record signal is recorded on the record medium, it is possible to perform the variable speed reproduction easily using the frame rate information by reproducing the record medium.

**[BRIEF DESCRIPTION OF THE DRAWINGS]**

**[Fig. 1]** is a diagram for illustrating a configuration of contents-providing system.

**[Fig. 2]** is a diagram showing a configuration of imaging apparatus.

**[Fig. 3]** is a flowchart showing an offer operation of sub-frame number.

**[Fig. 4]** is an illustration illustrating SDI format.

**[Fig. 5]** is an illustration illustrating SDTI format.

**[Fig. 6]** is an illustration illustrating SDTI-CP format.

**[Fig. 7]** is a diagram showing a configuration of another imaging apparatus.

**[Figs. 8]** are diagrams showing relationship (part 1) between the image data and the associated information.

**[Figs. 9]** are diagrams showing relationship (part 2) between the image data and the associated information.

**[Fig. 10]** is a diagram showing a configuration of signal-recording apparatus.

**[Figs. 11]** are illustrations each showing GUI

representation at an editing operation.

**[Figs. 12]** are illustrations showing a reproduction operation of the image.

**[Description of Reference Numerals]**

**10,10a**...imaging apparatus; **12**...imaging unit; **13,17**...signal processing unit; **14,18**...control unit; **15**...transmitting unit; **16**...user interface unit; **19**...audio input apparatus; **131**...camera processing circuit; **132**...audio processing circuit; **141,181**...imaging control circuit; **142,182**...timing generator; **171**...effective data selection circuit; **183**...effective frame signal generation circuit; **401**...material administration browser; **402**...story board; **403**...monitor viewer; **403b**...reproduction speed indication; **403c**...console indication for variable speeds; **404**...time line; **404a**...frame image representation region; and **405**...operation control bar.

**[Name of the Document] Abstract**

**[Abstract]**

**[Problems]** To judge how degree of frame rate in the imaging easily, thereby enabling the reproduction of contents to be easily controlled.

**[Solving Means]**

An imaging unit 12 reads a signal out of an image pickup device to generate an image signal Sp based on captured image. Signal processing unit 13 generates image data DV from the image signal Sp. By sampling analog audio signal Sin, audio data DA is generated. Control unit 14 controls operations of the imaging unit 12 and signal processing unit 13 to alter a frame rate of the image data DV to a predetermined set frame rate and to generate associated information for indicating the set frame rate or the like. Transmitting unit 15 combines the associated information DM with the image data DV and the audio data DA to transmit them as material data DTm. By generating the record signal based on the data combining the associated information and recording it on recording medium, it is possible to perform variable speed reproduction on the recorded image and audio easily using the associated information.

**[Selected Drawing]** FIG. 2

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【DCUMENT NAME】 DRAWINGS

FIG. 1
CONTENTS-PROVIDING SYSTEM

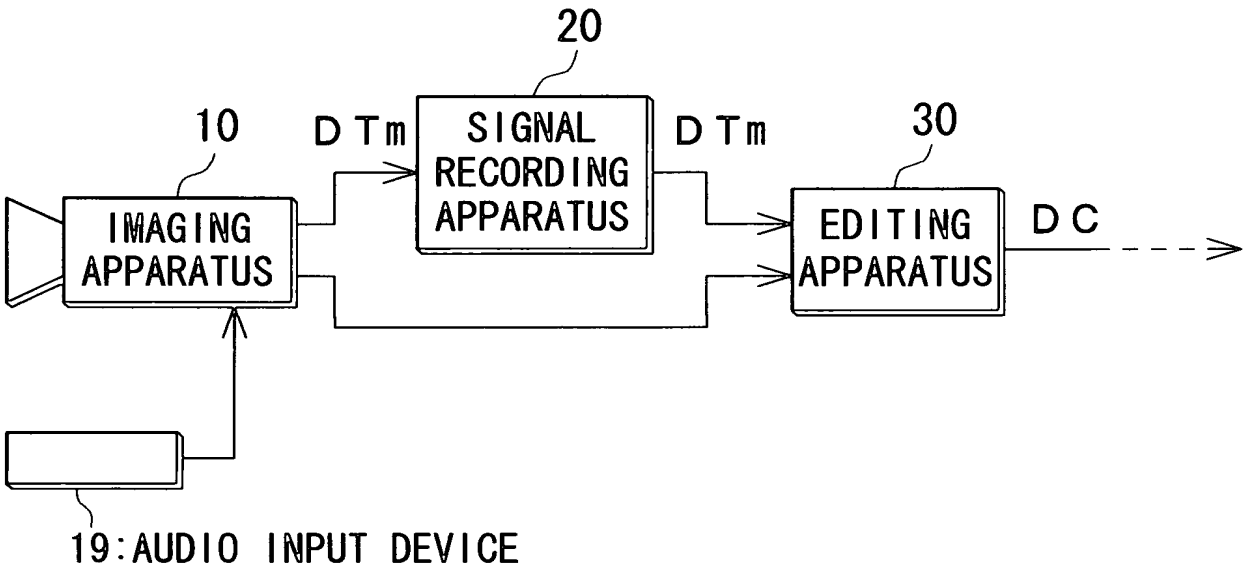


FIG. 2

CONFIGURATION OF IMAGING APPARATUS

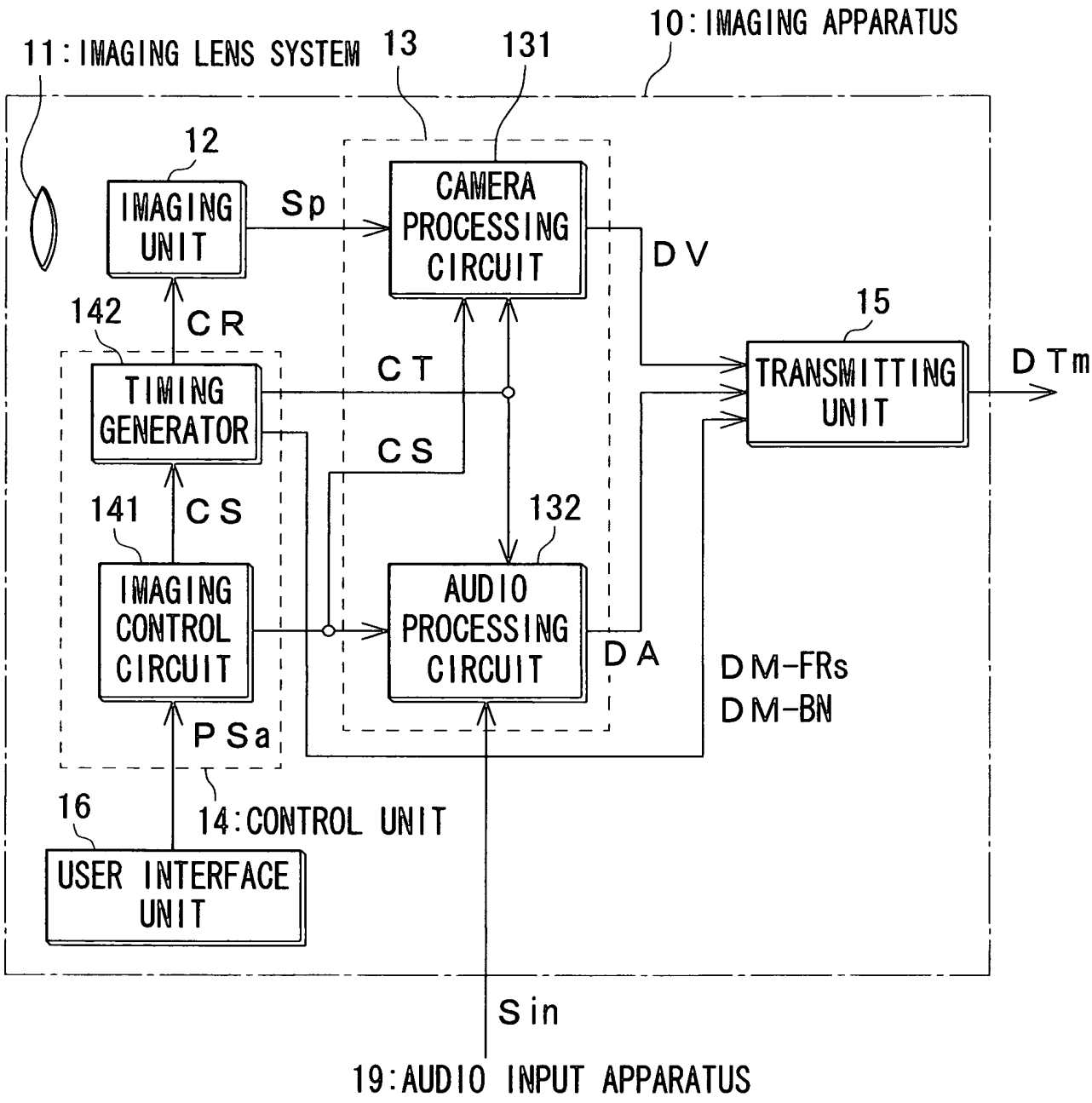


FIG. 3

OFFER OPERATION OF SUB-FRAME NUMBER

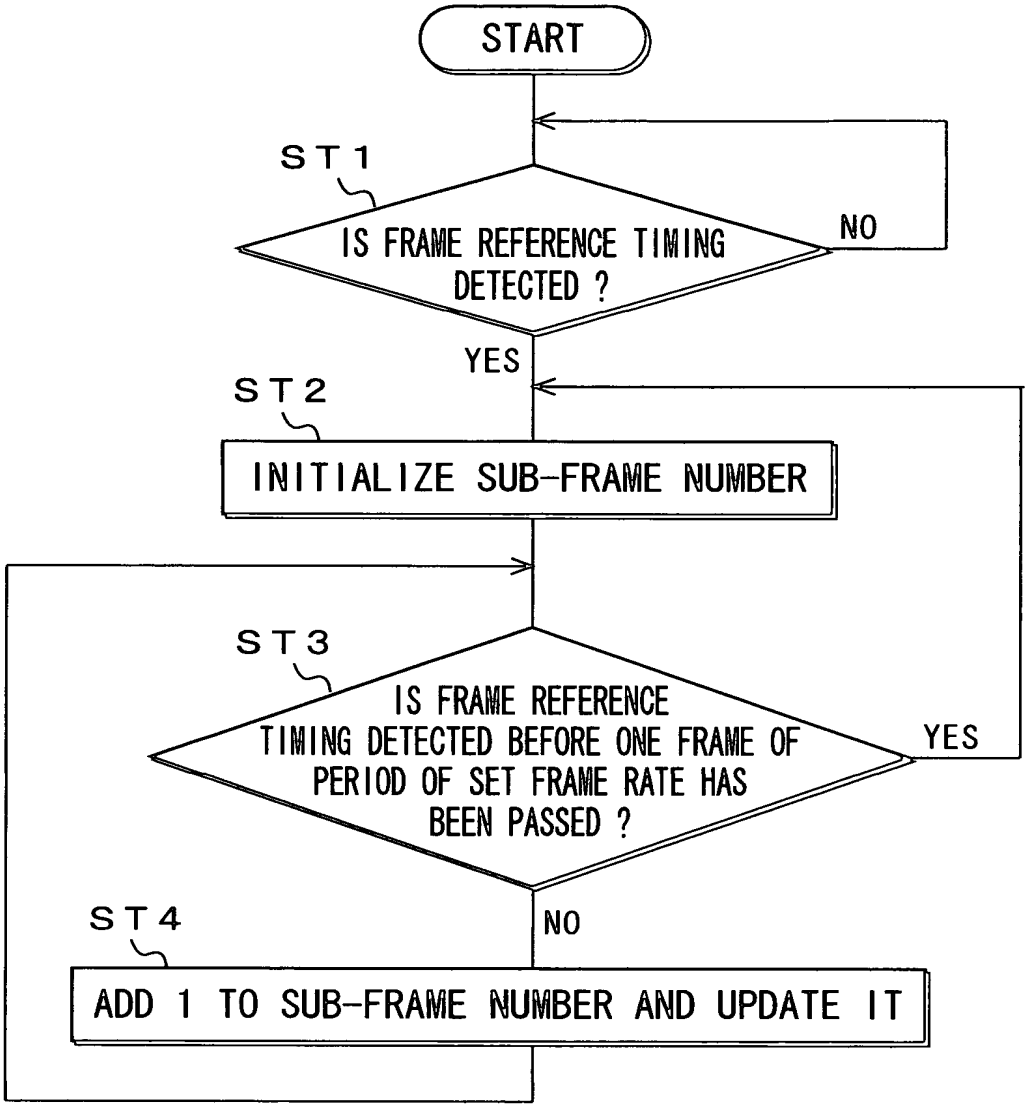
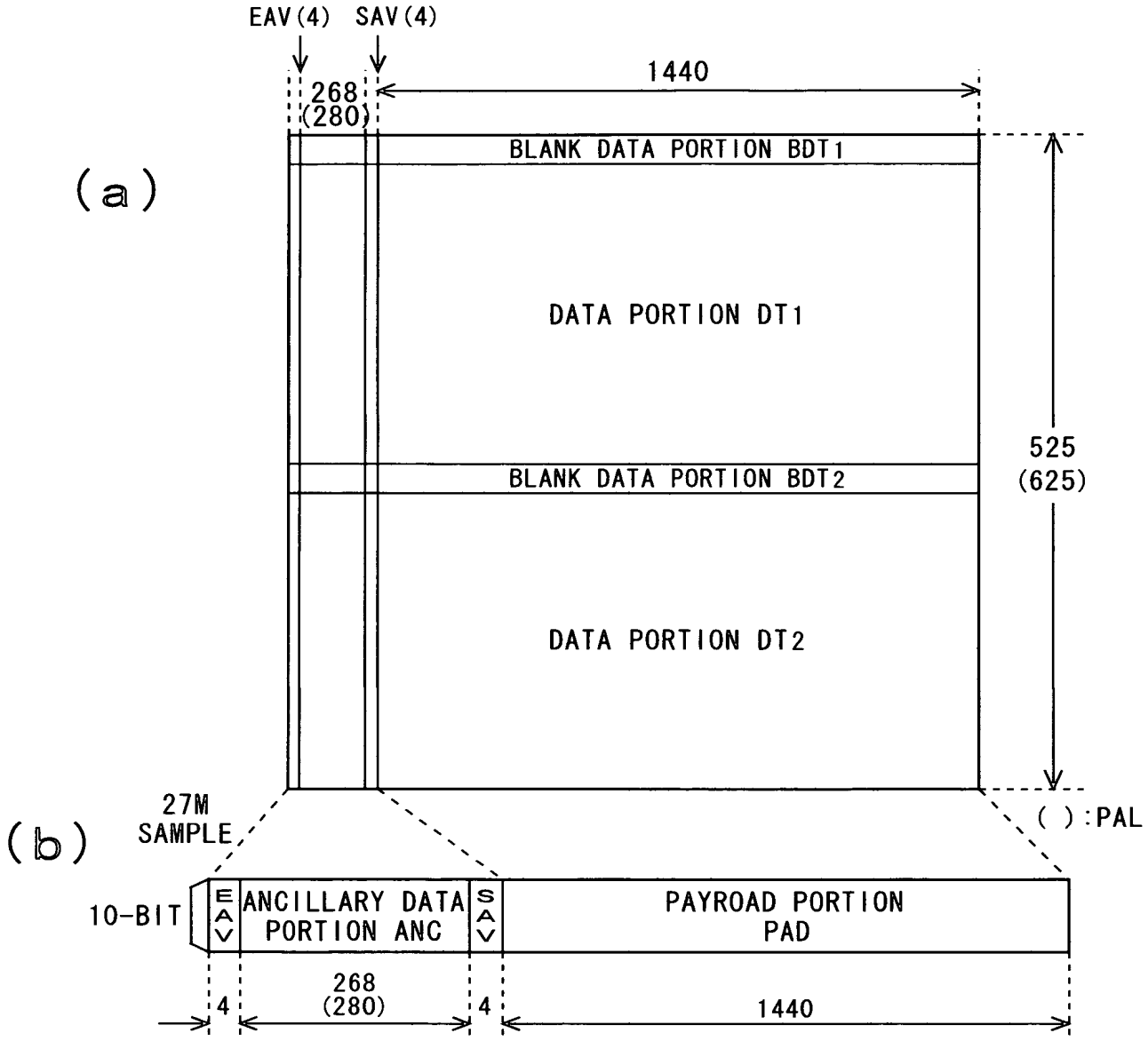


FIG. 4

SDI FORMAT



# FIG. 5

SDTI FORMAT

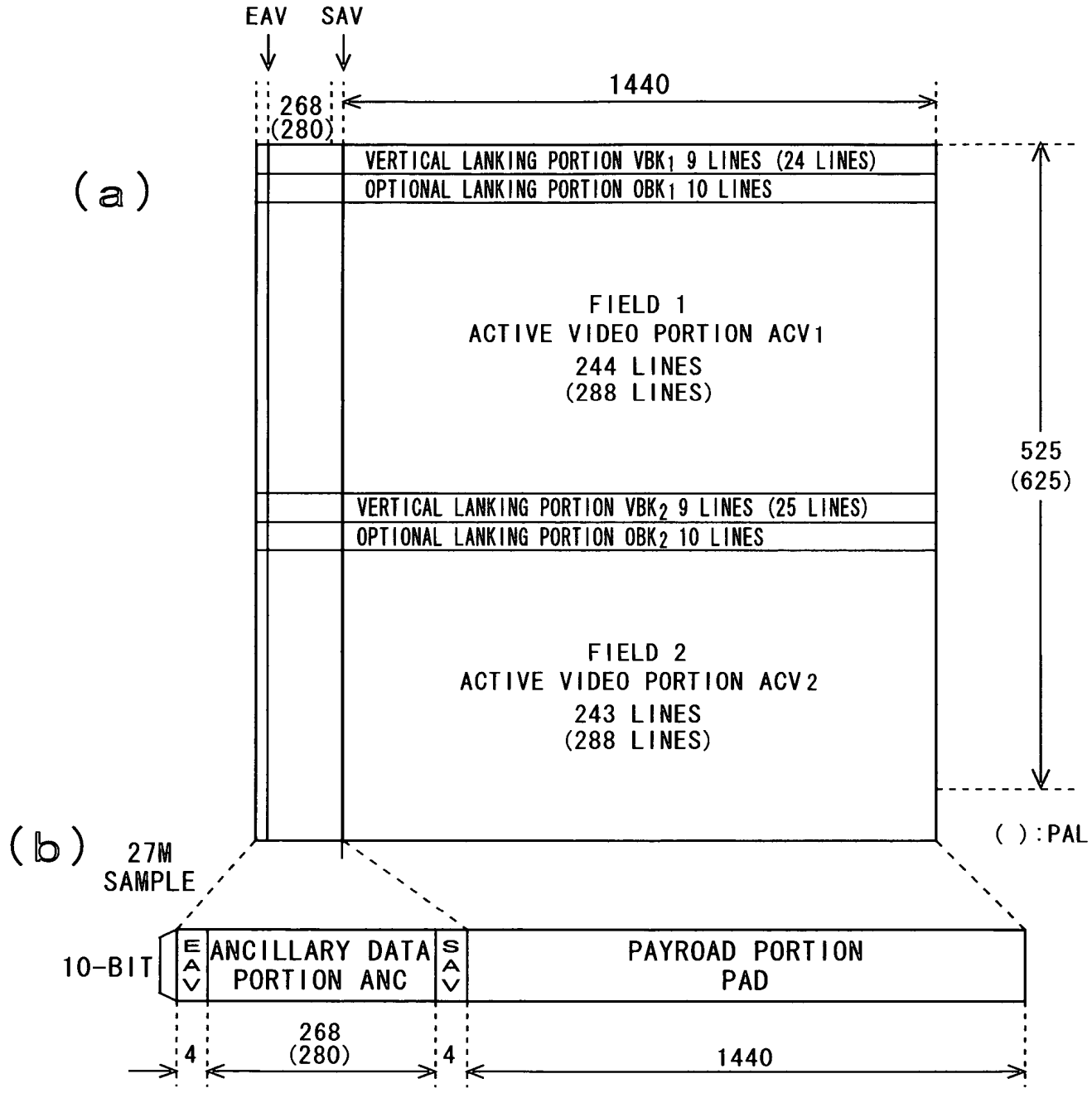


FIG. 6

SDTI-CP FORMAT

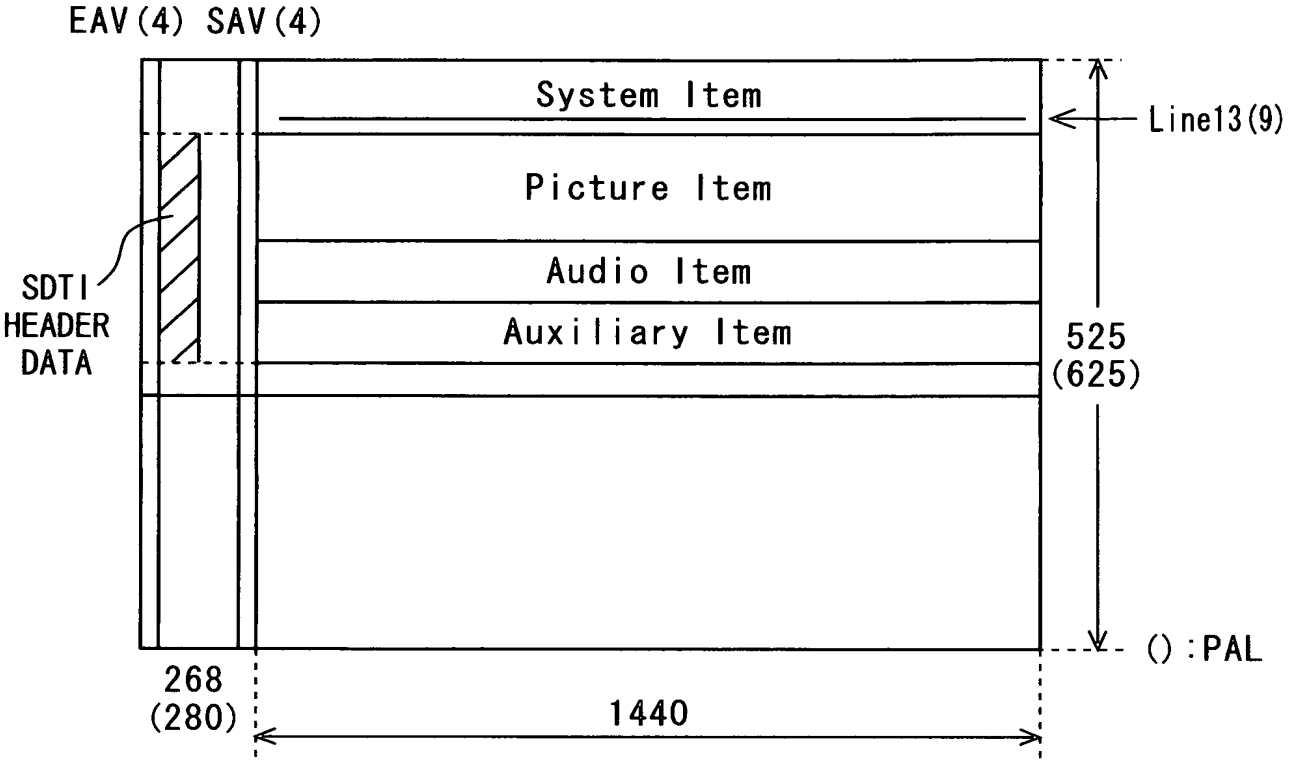


FIG. 7

CONFIGURATION OF ANOTHER IMAGING APPARATUS

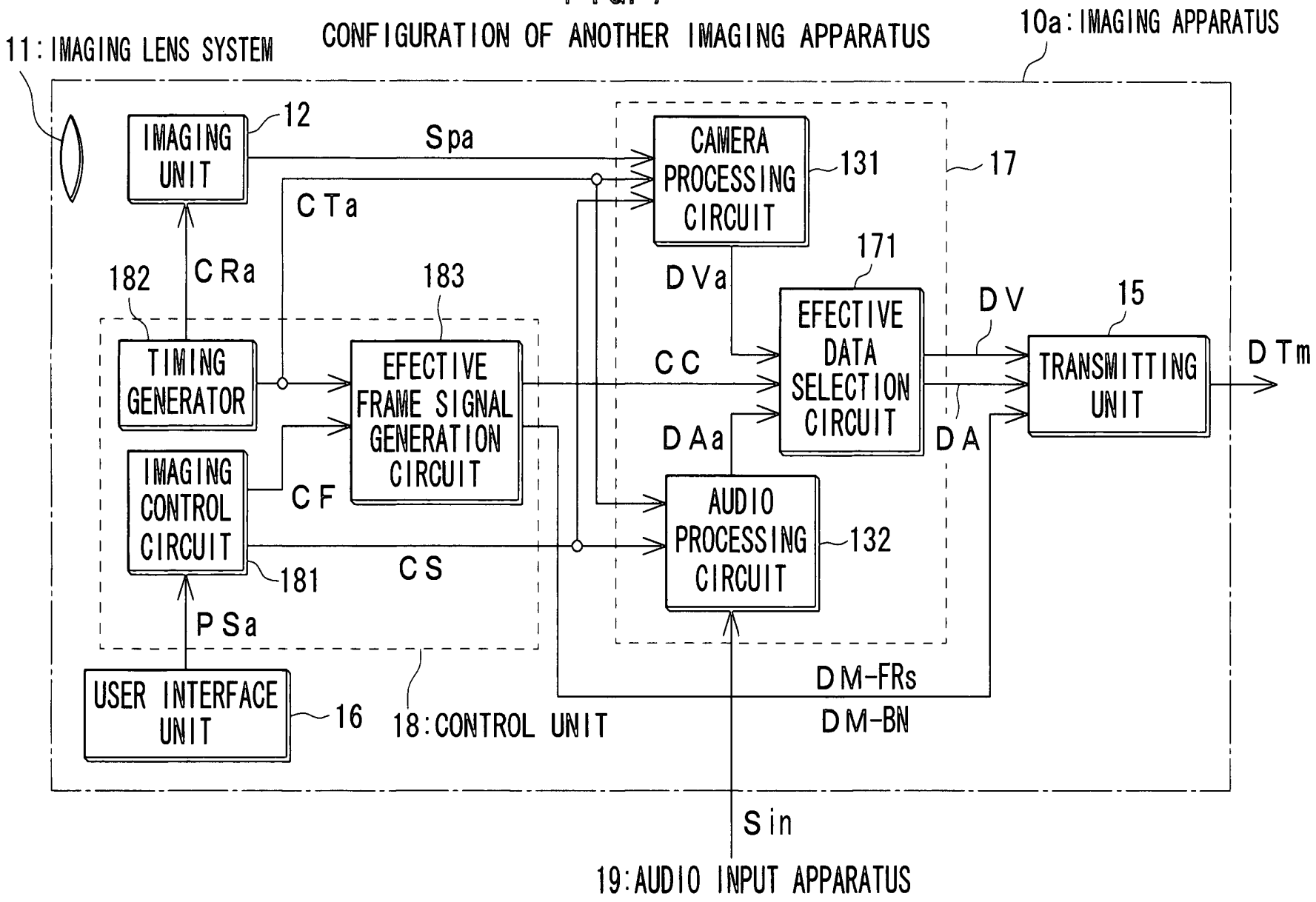


FIG. 8

RELATIONSHIP (PART 1) BETWEEN THE IMAGE DATA AND THE ASSOCIATED INFORMATION

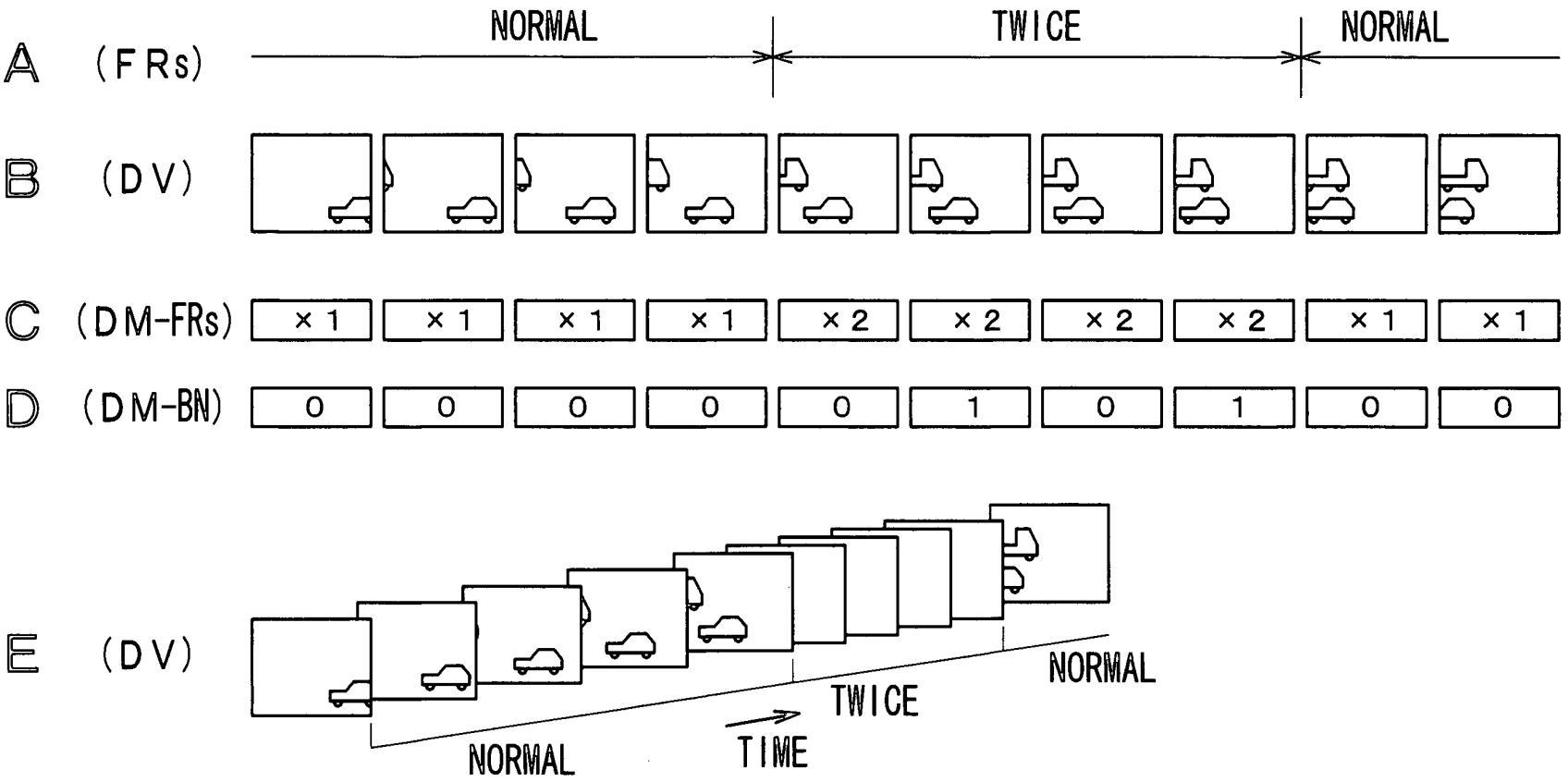


FIG. 9

RELATIONSHIP (PART 2) BETWEEN THE IMAGE DATA AND THE ASSOCIATED INFOEMATION

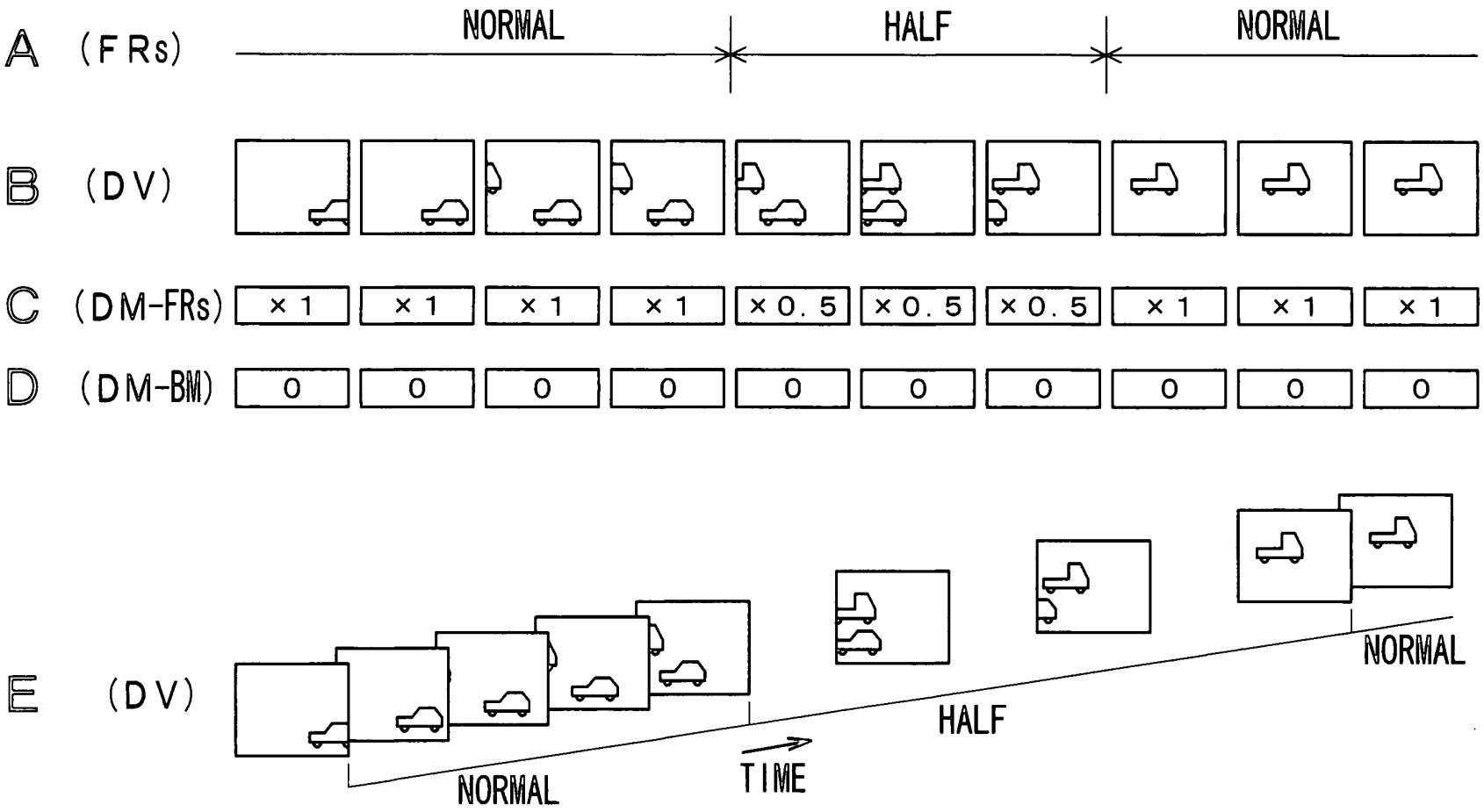
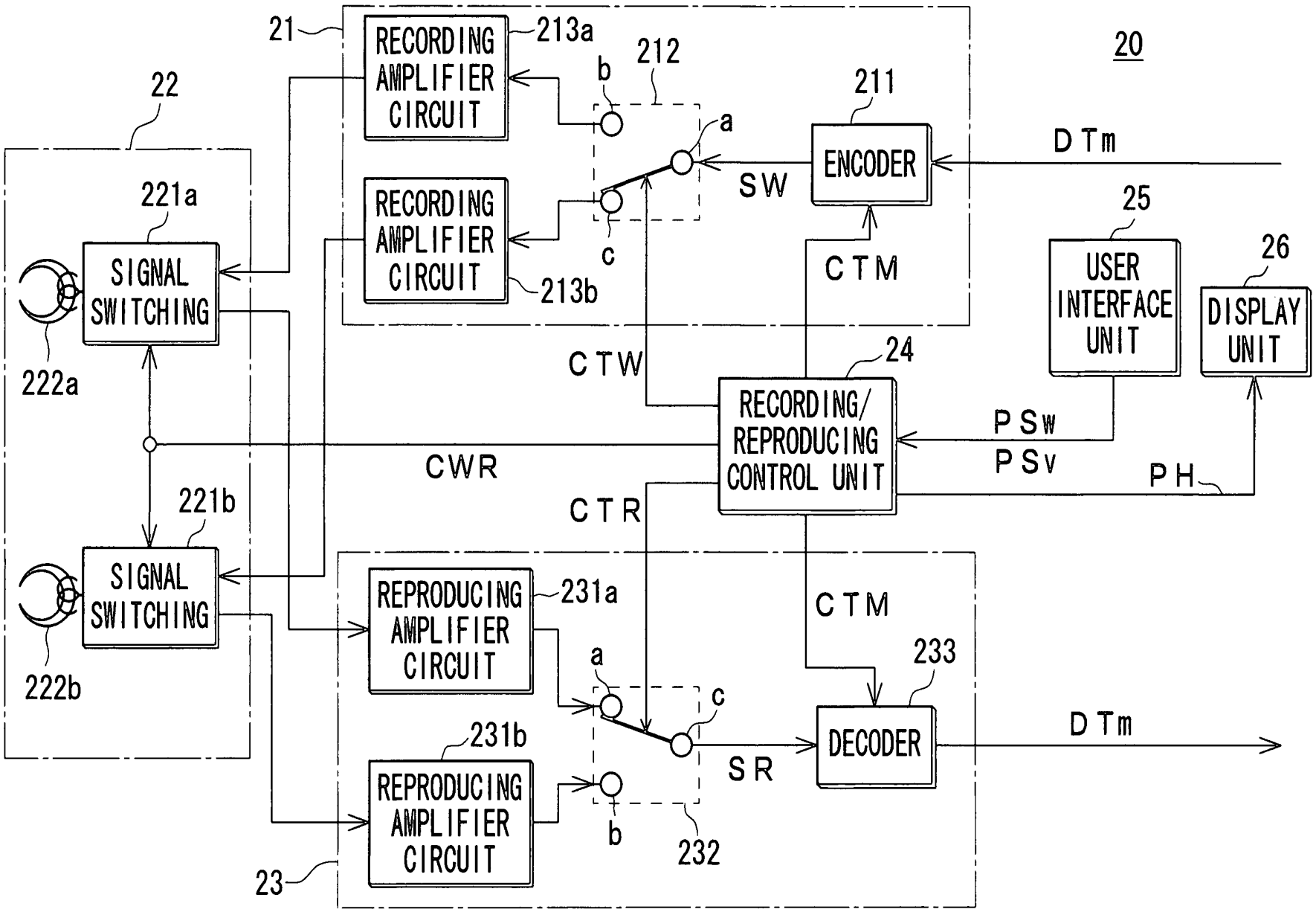
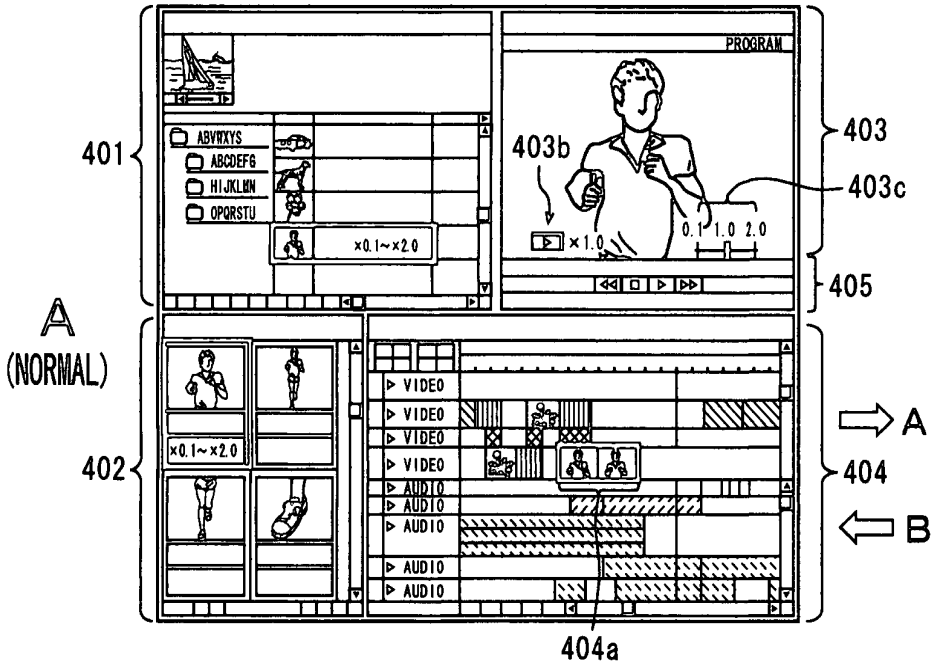
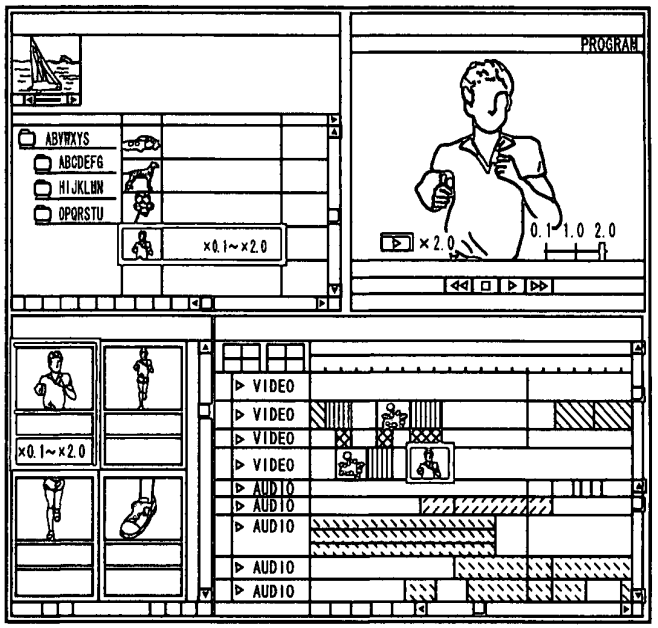


FIG. 10 CONFIGURATION OF SIGNAL-RECORDING APPARATUS





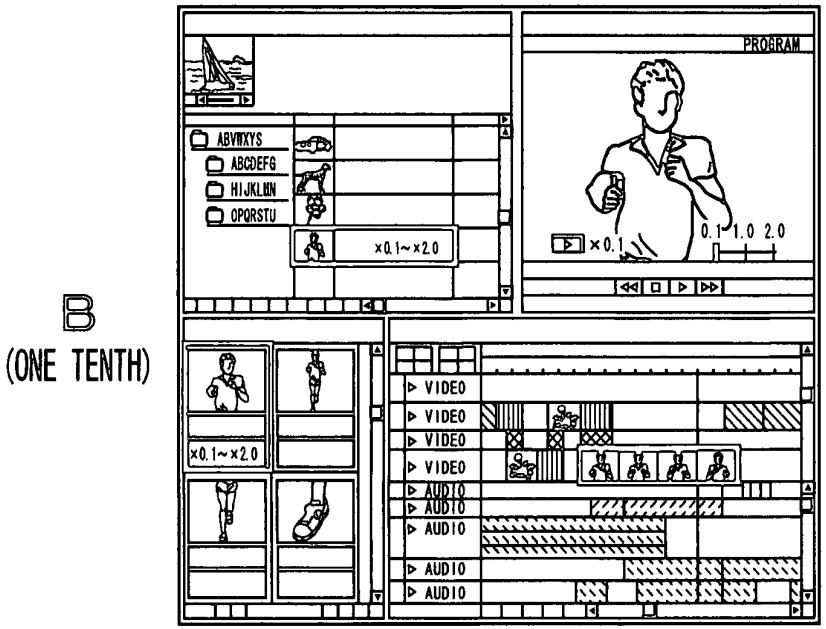




FIG. 11

GUI REPRESENTATION AT EDITING OPERATION

FIG. 12

REPRODUCTION OPERATION OF THE IMAGE